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ENGINEERING COLLEGES AND ADMINISTRATION.

BY IRA N. HOLLIS,

President, Worcester Polytechnic Institute.

It is difficult to write anything new on college administration. A list of papers that have appeared in our journal seems to indicate that the subject is threadbare. Most of our colleges have taken their own way, usually along the lines of

least resistance, without much agreement as to methods. A committee of the society was formed either to study administration or to write on the subject, but up to this time little has been done. Perhaps the subject is too complex for any generalization. Education is not like a manufactured article. It cannot be standardized without losing its soul. The success of an institution of learning is so much dependent upon other things than administration that it seems on the whole wise to couple that subject with the whole general question of preparation for the engineering profession.

Education is after all too much a question of the personality and the motive of the teacher to submit itself to well-defined rules, applicable to all cases. What is education? We can easily look up the definition in some dictionary, but is that enough? We must know what we are talking about and agree upon the end to which the education is directed before we can begin to discuss administration. That is my reason for associating the whole general problem of engineering schools with the conduct of their business and with the administration necessary to carry it out.

It is also worth while to define college administration. Heretofore everything outside of the recitation room or of the preparation of lectures has been called administration. One of my amusing experiences was in connection with a very young colored man who told me he was in the administration, when his job was simply helping to copy off marks and to distribute them. As a matter of fact all the business of a university or college is administration. The organization of the faculty and the graduation of the classes year after year all become matters of system especially where the work involves some responsibility and decision. In this paper I am using the word to mean everything outside of actual teaching; everything that interferes with the teacher's giving his entire time to study and to the preparation of lectures; everything that modifies in any way the companionship of a teacher with his students. The business function extends therefore from

the trustees, through the faculty and committees, to the handing out of marks and degrees but never crosses the line of the professor's real job, viz., to turn boys into good citizens well able to do the work of the world.

I have referred to the word education and I believe the best conception of it in an engineering school is to treat it as the process of teaching a boy the habit of work and a habit of thought in conformity with the times, or in some cases, in advance of the times. The main thing to be considered about education, however, is that it is not confined to the four years of college life which at best is only an oasis in the years of three score and ten. We all know that an engineer's training does not end with his degree. That forms only the commencement, and yet we rarely live up to our knowledge of this plain truth; for we generally shape the four years of study as if the young graduate were going to enter at once upon his practice as a full-fledged consulting engineer. Our Society has not had the influence upon education that it deserves and that it might have had under a more definite and outspoken program.

Few engineering schools have ever had the courage to take the plunge into a curriculum less closely connected with the commercial needs of the student immediately after graduation, and for that reason the engineering profession is often little esteemed. In the thought of the public it ranges from the blue-print boy in the drafting room to the man who holds the responsibility for building a great waterway, a great battleship or continental railroad. There is evidence among our own members of vague and unsatisfactory classification. The American Society of Civil Engineers is a well-organized association of experienced and capable men in our profession. There is no room in it for young draftsmen. A member must have demonstrated his fitness for directing important work. The American Association of Engineers founded a few years ago in Chicago is essentially a union not unlike the federation of labor for the benefit of its members. I am not trying

here to make an argument for or against either of these two engineering societies, as wide apart as the poles in some of their ideals. But, which one of them represents the end to which we as teachers are aiming? Undoubtedly draftsmen are needed and are useful in the work of our profession and some men will always remain draftsmen. With equal certainty great engineers will spring out of the obscurity of small places and small schools; but which type shall our engineering schools prepare to educate? Does the draftsman come from a school of a lower grade than the finished engineer or is the drafting room simply one step between the technical school and the profession of engineering?

About twenty years ago an old gentleman in Boston who had inherited and increased a great fortune, obtained through the work of engineers, expressed the view that engineering colleges should be organized to train routine men; that is, men to fill subordinate positions. While his money had come through the work of engineers he was voicing simply the desire and understanding of many trustees and founders of technical schools in America. They wish to provide the kind of men turned out by the German technical schools of the lower grade. It must be confessed that, while our professors have not this thought, the effect of their teaching and organization has been to carry out the idea of graduating men for a professional trade, and our four-year courses have in many cases amounted to simply advanced vocational training. In a few cases there has been a distinct recognition of higher education but in the main the organization has been planned for the graduation of engineers as young and as speedily as possible.

The articles upon administration appearing in our Journal during the past few years have usually referred to the efficiency of education as appears from the following brief list:

1. "Efficiency in Engineering Education," by Henry S. Munroe. (1910.)

2. "The Application of Scientific Management to the Operating of Colleges," by S. Edgar Whitaker. (1912.)
3. "Operating Engineering Schools under Scientific Management," by H. Wade Hibbard. (1912.)
4. "Scientific Management in College," by Earl F. Palmer. (1912.)
5. "Academic Efficiency," by H. H. Person. (1913.)
6. "The Relation of the Administrative Department to the Teaching," by C. R. Mann. (1914.)
7. "Academic Efficiency, Undefined and Unrewarded," by L. M. Passano. (1914.)
8. "Efficiency in College Administration," by S. B. McCormick. (1915.)
9. "A Plea for the Further Study of Efficient Methods in the Administration of an Engineering College," by C. C. Morris. (1916.)

Efficiency like a medicine must be taken in proper doses administered by a wise doctor if it is to have its high usefulness to an institution of learning. Wherever it takes the soul out of teaching or makes the records and the systems of more account than the actual education of the student, efficiency is worthless. We have an example of that in the organization of an entire nation to do its work and to secure a place under the sun. No nation has paid so much attention to the careful selection of men for the paths that have been marked out for them by a ruling class. The German method was introduced into America years ago and we passed through a period of worship of everything German from the workshop to the university. As a matter of fact their efficiency has betrayed the Germans into a false conception of their mission on this earth and into an entirely unnatural opinion of their relation to the Almighty. We find the professors in Germany throwing the truth to the dogs in order to assist Germany in obtaining dominion over the world. They have appealed to the passion of their countrymen to promote the ambition of themselves as super men. There is no greater curse to a nation or to an

institution than the blind worship of efficiency. The word has a high and fine significance when properly applied to the development of men and women.

"There is one glory of the sun and another glory of the moon and another glory of the stars; for one star differeth from another star in glory." Something similar may be said of efficiency. There is one kind of efficiency of the hand, another of the body, another efficiency of the mind or brain and another of human beings when acting in the mass. Yet they are inseparable in their influence upon civilization and happiness just as the glory of the moon is inseparable from the glory of the sun. We as teachers have separated them, but mainly through inability to look upon education in a large enough way. We must define then what we expect to attain before we can lay down even the trace of a road towards proper efficiency. We are in a position like that of a gunner who is firing the long-range shell at an invisible target. Calculations, and study, and allowances must be made and then the gunner cannot be certain that he is going to hit.

The schools of engineering are all trying to produce citizens who through their education and training are efficient in hand, body and mind. Any plan that sacrifices one of these to the other takes away from the value of our system of education. It may be well enough for a manufacturing concern to promote skill with the hand but we cannot limit ourselves in that way. The production of an article of commerce by a system that will either make the most money for a corporation or sell at the lowest price in competition with other corporations has been called efficiency. The development and use of the maximum amount of our natural resources has also been called efficiency. No writer has ever seemed to think of the finest thing that nature produces, men and women, as being the object to which efficiency should be directed. Any reduction in the cost of an article, in the time and effort to produce the article, without taking into consideration the human relation of labor to our whole social life, leads to a one-sided

view of efficiency. What is the good of a cheaper article if strikes are promoted? What is the good of anything in our modern industrial system if we are kept eternally on the rack? To-day no one knows what is coming out of the readjustment period following the war, mainly because we have had only a one-sided view of efficiency. Few manufacturers have ever directed their attention to the proper education of their own workmen in ordinary everyday economic truth. I refer to this whole question here not because it is entirely pertinent to the subject under discussion but in the hope that we may not overwork efficiency in our effort to improve the engineering schools.

It would be a mistake to dwell too much on the material side of education. In colleges attention is often called to efficiency in the use of rooms, efficiency in the use of laboratories, efficiency in the hour plan. Seldom is attention called to that organization which serves to make men. Any system is good that will permit the teacher to do his work and to maintain that happy relation found in the term—master and pupil. One has only to go back to the fourth and fifth centuries before Christ to find in Greece exactly that relation under which Athens developed in the leadership in art, literature, the drama, and even in the origin of science. We still go back to that fifth century as the fountain head of everything that we have, and it was done mainly through the schools such as that of Socrates and his pupils, of Plato and his disciples, of Pythagoras and his secret society on mathematics. Furthermore, the best that we have to-day in real teaching is the relation of great masters to their pupils. It may be said that there are few great masters. There would be more if our organization of colleges would only permit the type of teaching and class-room work that form a fruitful soil. I consider Mr. Taylor's work on system in manufacture, called "Scientific Management," perhaps the most important contribution that we have had in industrial science during this generation, because after all our principal development

concerns great masses of people. At the same time it is very easy to carry a system too far, especially when applied to a department where it cannot be made to fit. Scientific management in college education is absurd. We all know that there are faults and we all strive to correct them but we also know that in the relation of man to man and student to professor there is no such thing as scientific management.

I should like to make a confession here of views that have gradually become convictions in the twenty-six years that I have been in teaching at Harvard College and the Worcester Polytechnic Institute. What should be the relation of a teacher to administration? I look upon a good teacher as the best that a college can offer. The teachers are of far more importance to a university or college than even the graduate body or the students themselves, because their influence is felt far beyond the academic walls. It is to them that the graduates and students and the public look for the maintenance of our ideals in America, and it is their influence joined with that of the ministry that is the most far-reaching. A man of high character and fine human qualities in the classroom is so far superior to any system of administration that the routine of study is soon forgotten under the influence of such a teacher. There should be as little administration connected with such a man as may be consistent with carrying on the business, to the end that teachers may not be distracted from what is the main purpose of their employment. When a graduate carries into practical every-day life the memory of his association with an unselfish friend under whom he sat in the classroom he has a lasting and real influence for good.

We have lost a sense of true values in the intense commercial struggle of this century and in America we are too quick to look upon a transfer from teaching to administration as a promotion. It is a great misfortune to a college and to the teacher himself if he is taken from a highly successful relation to students to be put into administration, however well

he may develop therein. I well recall in the life of one of my friends the gradual lapse from teaching and investigation into the business of a large university department, and I cannot help but feel that while the university gained a fine efficient man in its business the world lost one of the best investigators and inspiring teachers I have ever known. Who could imagine a man like William James, or Longfellow, or Rankine, or Weisbach, or Rowland, or Aggasiz, expending his thought and effort on details of administration? It may be said that such men are exceptional. They are, and it is our misfortune in the teaching profession that they include no engineers, and that they will become more exceptional in our present commercial attitude towards all education.

It has sometimes been suggested that we do not make a proper statistical study of education and that therefore we lose efficiency. It might very well be asked, who is to make the study? I have in mind the kind of an investigation that was started in one of our great universities many years ago to determine the effectiveness of the university teaching. A questionnaire was sent out by the business office calling for information on all kinds of activities. The thing finally became a joke because some of the best-known teachers in this country were asked for the number of hours in the class room, the number of hours required for direct preparation of subjects to be presented to students, and the number of hours required for indirect preparation. Can any one picture the attitude of mind of Mr. James when he was called upon to tell a clerk the number of hours of indirect preparation for his lectures on philosophy? You cannot measure teaching by statistics. The influence of a fine teacher is something beyond price and the determination of class-room contents, standardization, the number of recitations a week, the cubic feet of air for each student, and other factory equivalents seem ridiculous when measured up against the services of master to pupil. Some reports have been published by the Carnegie Foundation and yet in all these matters relating to efficiency I have

been struck by a certain futility. One might as well take up the ideals of a people by counting the number of hours of attendance upon church in the course of a year, the number of square feet per christian attending, and the salary of the preacher per member of the church. As a matter of fact teaching cannot be standardized in its highest sense. It is better to tolerate some waste of money than to permit the morale of the teaching force to decrease and in that way to encourage waste of real brain matter.

Success in teaching is measured by the seriousness of purpose of the teachers themselves. We all know of course that certain sides of administration can be treated very much as the management of a factory. Care of buildings and grounds, the upkeep of apparatus and materials so that they will not deteriorate, and the procurement of materials needed for the laboratories, would classify themselves naturally under some kind of scientific management because the teacher's time ought not to be occupied with administration details any more than is absolutely necessary. Therefore, some kind of a business management ought to be devised to assist them and direct the time of the students. How many college teachers of any quality are there in the United States who will work under a system of scientific management directed by men who have no share in the teaching? There are very few. There ought to be some rules but the chief end is to educate a boy or girl and to make a first-class citizen, not a machine that has been through a shop and perfected by a certain routine method or for a certain definite purpose. Administration may well be directed to one point and that is the payment of professors so that they may have enough to live on with leisure to think about their profession. That is a fundamental question before the American people. If it is answered properly, good men will turn naturally to the teaching profession instead of turning first to commercial positions as giving them a better chance to bring up their families. We have too many cases of poverty among teachers.

The tendency of modern times is towards scientific methods. Everything is reduced to a statistical or tabulated basis and it does not seem to be worth anything unless placed on the ordinary rectilinear curve. It is a good thing in any country to get rid of illiteracy and to train every youth to do something so that his hands may not be idle but any system that shrivels up the soul is essentially bad for humanity and for the individual. Furthermore, any development that lacks the spiritual element renders science a real danger to mankind. We have evidence of that in this war. I have asked the question in another place "Is science safe for human beings?" It has been used for the last four years in destroying property and in shedding the blood of the finest that our nation has produced. Every invention and energy has been put to making science destructive rather than constructive. We have the element of danger always before us by putting into the hands of a few unbalanced extremists power to destroy men, women, children and property. The newspapers are filled with stories of crimes perpetrated by those who have used science without conscience. What gives this whole Bolshevik movement its hold but science combined with ignorance and a lack of conscience? Our ideals in engineering education should take account of this fact and the system should be primarily a training in conscience and the will to do right first, and then a technical education.

It is well worth while to review briefly the types of organization to be found in education. Reference has already been made to the most flourishing period of Greek history when the Greeks rapidly came to the front in everything that lies at the basis of human life and happiness. The only thing they did not have was the example of Jesus Christ but Christ patterned his methods on that of the Greek schools. A man like Socrates would set up what practically amounted to a course of lectures in the market place or elsewhere and his disciples would follow. Education has never flourished as it did under those men. There was no thought of efficiency or

system or organization—it was master and pupil or master and disciple. This type of school has extended down to our own times. It is what is meant by the saying that Mark Hopkins on one end of a log and a student on the other constitute a university. That seemed to be Mr. Agassiz' theory when he went in 1847 as a professor to Harvard College. He practiced exactly that type of teaching—master and disciple—and under him natural science immediately became popular in the United States. His pupils have been marked men especially those who studied under him in the little old wooden museum at Cambridge. Every one of them achieved distinction. There is an example of this in the German universities where the professor gives his lectures to those who choose to enter his courses. In a university, where there are many professors and many students some system has to be adopted so that the lectures are not all given at the same hour. Organization and administration, however, are never concerned with the class-room work. That is entirely a function of the professor. Even in the technical schools of Germany something of this idea prevails. I well recall some lectures that I attended in Charlottenburg when I was making a study of the German technical school system. One lecture on the compound engine was given by a professor who invited me to go into the class room with him. He was polite and there he introduced me to the two hundred and fifty students sitting in front of him. The lecture lasted one hour and a half. There was no textbook, no record of attendance, no conversation with the students. The lecturer simply went into the room, gave his lecture, and then walked out, the students being left to do the best they could to study up on the subject through text-books that they found in the library or elsewhere. I do not recall even any conferences with the professors and I did not see such a thing as a recitation. The main evidence of administration at Charlottenburg was the annual report written by the rector.

A modification of the German system was found at Harvard University under the unlimited elective system where a

student could take practically what he wished and graduate after four years of study, having completed seventeen and a half courses. This system has been modified so that all students are required to concentrate on a major subject and to skate around many minor subjects, but at Harvard the attendance was taken and there was some requirement as to annual examinations. The proposed new system at Harvard is to have examinations at the end of the four years of study on all the major subjects that students have taken. This means of course that no student can get through without a good general knowledge of at least one subject. Of one thing a visitor at Cambridge might be certain—he would find the class rooms of professors crowded if the lectures were presented by a man of real gift.

The most organized type of higher education is found in the prescribed systems of small colleges. They used to be classical and some still are classical but we have added all kinds of up-to-date subjects in most cases with a little election during the junior and senior years. Engineering schools, however, have as a rule a rigidly prescribed course of study beginning where the high schools leave off and continuing through four years gradually becoming more and more professional. Usually the first year is the same for all branches of engineering and the last year is exclusively technical.

The net result of this preliminary consideration brings us to the question, What is the place of an engineering school and what should it acomplish? This has a very direct bearing upon its administration. Another question might be added, Must there be only one type of engineering school? It seems to me foolish to lay any stress on the method or type as being the final word. No engineering education can be standardized without running the risk of losing much that is valuable in the individuality of different teachers. As a matter of fact most men make themselves and a course of study has little to do with the magnitude of their careers. Often it has nothing whatever to do with their occupation in life. Any school will prove this fact and make plain that

a man's chief education comes with experience in life and from study after graduation, sometimes retarded by a course of study which has to be unlearned. The man's education, however, must be his own if he is to achieve any distinction whatever.

I take as an illustration of a rigidly prescribed course, the United States Naval Academy, because I am familiar with it and because it is one of the best examples of a curriculum that has no elasticity. In the first place it is strictly utilitarian in the sense that no attention is paid to anything that does not count towards the training of a naval officer for sea duty and for a limited number of international problems that may arise between our country and foreign nations. Everything that does not find a use is excluded. There is no great attempt at real teaching. It is a "sink-or-swim" method. The lessons are given out and the midshipman must learn them for himself or fail. It is really a case of intensified training and discipline and then of careful weeding. Our courses in engineering schools must necessarily be on a broader basis because we never know beforehand just what branch of the profession our graduates are going into. That often is a question of opportunity and the industrial condition of the country. Nevertheless the great majority of engineering schools are like the Naval Academy minus the discipline. The Navy always knows what its graduates are going to do and the energies and organization can therefore be directed to that one thing—to make men for the best fighting machine in the world and to fulfill its purpose and function better than any school in the United States or perhaps in the world. Theodore Roosevelt once told me that he considered the Naval Academy the finest school in the world, meaning by that that it carried out its function better than any place else in doing what it set out to do. And what is the result? It produces good officers who have shown in this late war their capacity to work efficiently and enthusiastically. But it goes further in that it graduates a large percentage of men who leave the Navy and go into other professions entirely

outside of the course of study. They obtain their education for their work on top of the Naval Academy training which is valuable only through its discipline. It is easy to show what graduates of the Naval Academy have been capable of doing by simply naming a few of them: In history, Alfred T. Mahan, who opened up a new field for historians. In literature, Winston Churchill, Cyrus Townsend Brady, whose novels most of us have read. In invention, Frank J. Sprague, the father of the trolley system. In education, Mortimer E. Cooley, who built up the first great engineering department in a university. In business, Homer L. Ferguson, lately elected president of the U. S. Chamber of Commerce.

It is not intended here to give any list of the graduates of the Naval Academy who have distinguished themselves outside of the Navy and the purpose of this reference is only to show that men who have acquired the power of application and the initiative to do something with themselves are not dependent in any way upon the curriculum of any school, its organization, or its administration. They find their chief stimulus either within themselves or from teachers like Louis Agassiz. We get back then to the question asked before—What is the purpose of an engineering school? It is to train a large number of men for the ordinary business of engineering, leaving to the exceptional who are capable of striking out into new fields the education of themselves. An engineering school may well have a semi-military character as the student is to graduate into a profession requiring system and accuracy but it does not follow that he must be turned into a machine by methods reduced to a standard.

We have certain illusions in our schools. One of these is that a teacher of engineering is a great asset if he continues his activities in the practice of his profession. As a matter of fact he is often a brake upon the development of first-rate teaching. If he is a good teacher, the time spent in outside business is a distinct loss to the institution with which he is connected. There is a lot of loose talk about keeping up with the advance of science and its newest applications. We in

engineering education know that the fundamentals are more important than anything else, and that the best method of keeping up with the times is to learn the best method of presenting fundamentals, not of keeping an array of facts before our students, even though these facts spring from the latest investigations. A man cannot ride two horses except in the circus ring. The work of an engineering school is far more fundamental than the latest advances which in their turn in a very few years, often before the young graduate has really gotten into his profession, become the antiquated practice of a rapidly receding past. We are in the profession of teaching and time spent in studying the methods of presenting a subject to students is far more valuable than the same time put into practical application. America has been a partial failure in its engineering schools because it has developed very few writers of first quality. Our books are usually slipshod, prepared at odd hours between the preparation of lectures and the practice of consulting engineering, simply because our teachers have been encouraged to supplement their insufficient salaries by outside work. We are thus in the habit of flattering ourselves with the thought that we are keeping up with the times. The only really practical advantage in a teacher's connection with outside work is that he stimulates the imagination of his students and in that way obtains from them a larger measure of effort and interest.

Another illusion that is common to colleges is that the subjects taught in an engineering school must necessarily be less broadening than the subjects in non-professional colleges. That is not true of the engineering school that devotes itself mainly to fundamentals. There is not a subject fit to be taught in a technical school that cannot be broadened and enlarged to make it a real education. In 1893 the engineering courses at Harvard College were completely revised and every one of them, except the workshop courses which were almost exclusively hand work, were accepted as part of a liberal education for the A.B. degree. This was freely granted by the teachers of classics and others on the Harvard

staff. Unfortunately all teaching for the profession of engineering was given up when the agreement was made with the Massachusetts Institute of Technology.

The administration of a college differs ordinarily from that of a business corporation in that it must be more democratic and must take more account of the wishes of those who are employed in its service, and the teaching force must be consulted and controlled only so far as to hold the institution together. A good teacher can always do his best work when free to direct his energy in the manner he considers most advantageous to his students and in a way that will develop his own thought as well. His profession confers upon him responsibilities and privileges on economic, social and scientific questions sometimes difficult to reconcile with the views of boards of trustees; hence the discussion of the words "academic freedom." On the whole it is better that a teacher should be free to discuss any subject so long as he does not disgrace himself or degrade the institution, and this applies to engineering schools as well as to the larger universities. When we contrast the behavior of our professors under a system that does not put restrictions upon them or require any special doctrine to be taught with the behavior of the German professors and their betrayal of both profession and country in the support of military Prussia we must find a real reason for congratulating ourselves upon the freedom of thought in the universities, colleges and technical schools of our country. Fortunately we have no privately endowed institutions that have any tendency to inflict upon their teachers a particular political partisanship or any phase of academic doctrine.

College administration must take account of the fact that the highest aim in any school is enlightened citizenship in this republic, in addition to the specialties for which the school is founded. In this regard we sometimes are tempted to separate the technical school from the ordinary college but the purposes are not essentially different and we may better emphasize the likeness rather than the differences. An engi-

neering school is intended to supply a young man with at least the introduction to a profession as well as his general education, while the college attempts merely a general education as a basis for subsequent professional study. Attention has already been called to the fact that most of the subjects in an engineering school if properly taught are capable of being broadened out into a general education. It is entirely a matter of emphasis and the personality of the teacher. We hear much of the broadening of a great university and yet the broadening springs largely from the fact that the university has money enough to employ teachers to whom a large amount of leisure for thought and study is given. A good man has a broadening influence without much regard for the subject that is taught. Greater consideration ought to be given to the type of man who is teaching. A really inspiring teacher could make of a course on steam pumps something vastly more effective even in the teaching of English than a young assistant of no experience in life could make out of the teaching of English itself. Let us remember this in connection with administration of colleges and in the selection of teachers.

A study of administration may be taken up on a considerable scale by assembling and classifying all college catalogues, but I find this method comparatively fruitless. It is better to make an examination of comparatively few typical cases remembering that the personality of the men in the administration has far greater influence upon the results than the exact organization itself. Consequently I am concerned here mostly with the kind of administration under which teachers have the greatest amount of freedom and under which the student finds the greatest stimulus to study.

All the activities of an engineering school may be divided among comparatively few heads.

1. *The Financing of the Institution.*—This is a matter largely for the trustees and for the friends of the school, and it should not be a part of the work of the teaching staff. No fixed rule can be made inasmuch as privately endowed

colleges must get help where they can through teachers or anybody who is effective. There is one matter to which the most scrupulous attention should be paid; viz., that the income from funds should be used so far as it is possible exactly for the purpose named in the deed of gift or in the bequest. If there is one place on this earth where the truth should prevail and where a benefactor should obtain exactly what he requests, it is a college. Truth and honor should be maintained at the expense of refusing some gifts.

2. *The Plant and its Maintenance.*—This is a business matter similar to that of any commercial establishment. The principles of scientific management may very well be applied in the care of buildings, laboratories and all property of an institution of learning without in any way interfering with the relation between professor and student. The business side of a college should not be put upon the members of the teaching staff if it can be avoided; at the same time a superintendent or agent should hold his position only by his acceptability to teachers, his understanding and sympathy for their work.

3. The use of rooms and laboratories, the hour plan of recitations, the penalties and rules, and the physical training, all of which constitute faculty business, to go before the trustees only where they involve money or question. So far as possible the faculty business should be committed to standard committees on discipline, on records and on the enforcement of rules. It has been customary in the past to carry cases of discipline to the faculty but it is of doubtful wisdom except for the information of all teachers; even dropping a student for being unsatisfactory in his studies can be made a function of some committee.

4. *The Teaching in the Class Room.*—This is always by means of lectures, demonstrations, recitations or conferences and will form the purpose for which a school is established. This must never be lost sight of. All organization leads to this end and to nothing else.

5. *Relations with Students Outside of the Class Room.*—

This is so much a matter of informal daily contact between professor and student that no rules can be laid down. It will always be dependent upon the temperament and sympathetic understanding on the part of the teacher and it is possible that this beautiful relation may be the best thing that a student gets out of his college life. The fine service that goes to build up a boy's character is more an asset for citizenship.

6. *Student Activities.*—A college that does not encourage in some way student activities outside of the class room becomes too rigid and it does not produce a type of graduate who can adapt himself to the conditions of everyday life. Some religious schools are of this kind and many engineering schools over-crowd students so much that they have no time for what might be called a course in human relations and friendship.

I have no intention of dwelling on these matters. They have to do with administration only so far as the background is naturally made by the governing boards. The first three of them relate entirely to the business of an institution and the last three to the education of young men. The whole purpose of this paper would be misunderstood if it is interpreted to mean that I do not believe in efficiency and good business administration. I do most heartily believe in both and in a proper organization but never at the sacrifice of that human relation which does more to turn a boy into a good man than all the organization in the world. I have dwelt on the word efficiency because we have made a fetish of it. Of course we all know that an engineering school is primarily an institution for teaching engineering and for giving a young man his start in the profession. Consequently the primary purpose relates to science and the things that a student must learn form part of the profession. That is first and organization should have that in view, but again I repeat, never at the expense of the soul.

Every college has its board of trustees, sometimes called a corporation, a board of regents, or simply a governing board. It makes no difference under what name this board appears

it must necessarily take responsibility for the institution. There are two types of organization of trustees; one is a single board like a business corporation, and the other is a dual board like a business corporation with a senate that must pass upon its acts. In some cases these boards are elected or appointed and serve for a term of years. In most cases, however, the members hold a life tenure and the board is self-perpetuating. No two colleges are managed in exactly the same way and there are many types of boards. In order to bring before the Society a complete exposition of this matter it would be necessary to exhibit the framework of every university and college in the United States. They may be divided as above into two types, a few examples of which will be sufficient. The old style college still exists in places like Bowdoin, Amherst and Williams, and they fill a very useful place in our system of education. They have their board of trustees made up in part of ministers and in part of business or professional men elected with a life tenure. We are not concerned with these so much as we are with those that have engineering departments or are solely planned for engineering education.

Yale University has a corporation consisting of the president and fellows, in number nineteen, elected either for life or for a term of years. The Sheffield Scientific School has also a board of trustees of nine members. This board is a corporation, three of whose members are ex-officio, viz., the governor of the state, the president of Yale College, and the chairman of the Peabody Museum trustees. The other six hold a life tenure and fill their own vacancies. The director of the Sheffield Scientific School is the secretary of the board. It will be observed that the graduates of the Sheffield Scientific School have no voice in the government excepting so far as they may be chosen by the surviving members to fill vacancies. The organization at Yale will probably be affected by the general discussion now going on.

The Case School is apparently incorporated and is held by a corporation of twenty-two members. The business of the

institution is directed by a board of trustees consisting of seven members chosen by the incorporators. The graduates would have no voice excepting as they are chosen to be trustees, and the president is not a member of the board of trustees either by election or ex-officio.

Rensselaer has a board of trustees consisting of twenty-three members holding a life tenure and the mayor of Troy as additional ex-officio. The president of the institution is also president of the board of trustees and the graduates apparently have no voice in the choice of the members. This case is much like the old-time board of trustees for colleges.

The Massachusetts Institute of Technology has a corporation consisting of fifty-three members, the president, the treasurer, the secretary, the governer, the chief justice, and the commissioner of education, all of Massachusetts, being ex-officio members. There are thirty-two life members and fifteen term members, three being elected each year for a term of five years. There is besides an executive committee consisting of the president and treasurer and five members who are chosen by the corporation from among its members for a term of five years. This committee has power in all appointments and fixes the salaries and duties of all officers. It has entire responsibility for all the property of the institute. The fifteen term members of the corporation are elected by the corporation from a group of candidates submitted by the alumni of the institute. The corporation as a whole confirms appointments, confers degrees and authorizes certain financial transactions.

Harvard.—The government of Harvard is by two completely independent boards. The first board is known as the corporation, consisting of the president and treasurer and five fellows, called usually the president and fellows. The members have a life tenure and vacancies are filled by the surviving members. This corporation transacts all business, makes all appointments, and in general may be regarded as the directors of the institution. A second board, called the overseers, consists of thirty members. Five of these are

elected every year for a term of six years, at the end of which time they are eligible for one more term of office. The board of overseers approves all appointments without limitation as to the time and in general takes up questions of policy submitted by the corporation. The president of Harvard is chairman of the corporation but is not a member of the board of overseers.

Michigan University.—This university is a fair type of the larger state universities although no two of them have exactly the same plan of government. Michigan has a board of regents consisting of twelve members. Of these the president, the treasurer and the secretary, and the superintendent of public instruction, are ex-officio members of the board without vote. The other eight members are elected for a term of years by the people of the state and apparently form a committee to direct all the educational and business affairs of the university.

Other universities and colleges have all kinds of modifications of these six plans. The general tendency is towards a greater participation of graduates in the affairs of their alma mater and ultimately the colleges will probably be governed by the alumni asociations. Furthermore, the dual organization is probably better adapted to private schools than it would be to state universities whose boards have a limited tenure of office. A permanent board is likely to become more or less inactive in course of time, especially if there be associated with it one or two men who carry the financial burden on their shoulders. It is not a sign of prosperity for a school to possess some interested individual who is ready to step forward to pay all deficits. As has already been stated, the character, interest and personality of the men on the board of trustees is of far greater importance than the exact type of organization and the same thing holds with regard to a faculty. Every one of the different schools may have its own individuality without necessarily having inferior methods. The important thing is the man who is sitting in the classroom chair, it is his influence that will tell upon students in

the long run. The relation between the board of trustees and the faculty is important. Often the trustees, who are business men, cannot be brought to take a real, intelligent interest in the work of the class room. Occasionally they take too much interest and meddle with the teachers. There has been for years a discussion about giving the faculty a share in the government of an institution and sometimes teachers have felt that the president of a college has altogether too much power. Some reports have been drawn up on this subject. It would seem to me unfortunate to have the members of the faculty pass upon a number of questions that now belong peculiarly to the trustees. I do not think that any professor can possibly be in a comfortable position when he is passing upon the salaries of his own colleagues. This is true even in the departmental government of a college where the head of a department assumes to decide the salary and work of a teacher associated with him.

It would be useful to have occasional meetings of trustees and teachers on certain larger questions of policy like entrance conditions, the courses of study as they ought to be given and the enlargement of the curricula, but when it comes to the actual share in the executive management of an institution the teacher is in a totally false position. His time would be taken away from the essentials of his profession and put into chores. The grievances expressed by some faculties are largely in the nature of appointments and dismissals. It is perfectly obvious that a man who is appointed a professor should be acceptable to his colleagues unless some reorganization or reform is absolutely needed to better a bad situation. Consequently, the appointments in any department ought to come by recommendation or consent of the appointee's future colleagues. If such recommendation comes only from the head of a department, it might as well come from the president of the college. In the matter of dismissals a professor who has taught for many years ought not to be lightly dismissed and the whole subject ought to have full investigation by the trustees. I have heard many busi-

ness men say that teachers were employees in the same sense as men in the industries. They are often treated in exactly that way but I think it is a great mistake. The profession of teaching is like the ministry a privileged profession and a man who has taught twenty years is in the same position as a preacher in regard to the outside business so that if he is dismissed he is comparatively helpless. I have known a few preachers who have turned to soliciting life insurance as a means of getting a living and there is no more melancholy sight in the world than an old teacher who has no support. As a rule the pay is not enough to enable teachers to lay by any money for their old age, hence they cannot be treated as to appointments or dismissals in the same way as a man in a business position. The value of a teacher's work is very rarely measured by his pay as will readily be disclosed by the great variation in professors' salaries. They vary from $1,500 per year up to $7,000 or $8,000 depending upon the institution, and yet a professor in a small college probably does as good work with his students as those in larger ones.

The Carnegie Foundation has provided a method of taking care of the most serious cases of breakdown in the college service and of getting rid of those whose usefulness has passed by reason of illness, or old age. In future the Foundation will not have so great a power in the matter as it is changing to a type of insurance company.

One often hears the statement that professors are not business men, as if that were a reproach. We may be thankful that they are not. Let us have in America some place and some profession that is not commercial so that we may at least preserve the finer ideals of our forefathers. If a teacher is a good business man he would better go into business and let teaching alone. If he is a good teacher and is capable of stimulating a higher type of character in the student, he ought to give up all thoughts outside the class room. If he is neither he might better be on a farm.

What is the place of a president of an institution of learning? Few of the foreign schools have any such organization

as we find in the United States. In England and Germany there is no such thing as the president of a university or college in our sense of the word. The head of the Charlottenburg school is a rector appointed by the government for one year. All appointments to professorships are suggested by the faculty, usually three names are handed in to the government and from these one is selected by the minister of instruction. If none of the three names are satisfactory to the government, three others are submitted until a man is obtained that the minister of instruction will accept. While this apparently is a democratic and open method of appointing professors it really does not differ from the American method of going after the man that is wanted. The president of a college in the United States holds a position very largely as business manager in addition to being at the head of the educational side of the university or college. But his position is often distinctly inferior to that of a teacher who has leisure to study and write. The position is not, however, that of an autocrat as the holder must remain acceptable to the trustees, must find money to run the institution and must be able to convince teachers. On the whole it would be better if the president of every college were the disciplinary officer and had the care of scholarship and loan funds. Whether a changing head such as that in Germany would be good or not in the United States has never been thoroughly tested. The University of Virginia gave up an old system to have a regular president. Probably the present practice of electing a president into whose hands is placed the business and educational matters of the institution is well adapted to the American mind and cannot readily be changed. One of the difficulties with the position, however, is that often too much business is put on the shoulders of the president who has no time for educational matters. This fact has led in many colleges to the appointment of a business agent or a publicity manager to serve with the president in certain business matters outside of the teaching field. Only the larger universities have money enough to separate business from teaching. The tendency of business

agents who do no teaching, however, is unfortunately towards commercial methods. Especially is this true of publicity men.

The method of bringing colleges to the attention of the public and bidding for students is very much the same as we find associated with the sales department of any manufacturing company. In some parts of the country the college drummer is sent out to get trade and all kinds of publicity propaganda are devised to lead students to attend the colleges advertised. I believe this to be altogether bad. It may be said that more young men are thereby induced to educate themselves but I do not believe that to be true. A large number are misled into thinking that they ought to get a college degree than are helped by the advertising method. Should engineering schools advertise at all? It is doubtful. Their publicity ought not to extend further than a good description within the catalogue of what the college offers. We ought not to acquire the competitive spirit so much that we shout with joy if we can only show a few more students than our neighbor who is also teaching engineering. The newspapers are filled with stuff of that kind from the larger universities. It usually emanates from publicity agents who are employed to keep the institution before the public which is often deceived as to what the colleges are really capable of offering young men. One of our colleges has a publicity agent who is going out to get 400 more students. The pamphlet by which these students are to be obtained has the same misleading quality found in advertising departments of business houses and represent to my mind the last state of degradation in education. There would be a distinct gain if all engineering schools and engineering departments would join to offer within the same binding a brief description of their names, purposes and work. This could be sent out all over the country and would serve the purpose of indicating the opportunities for education in our profession.

How should a faculty be organized? Undoubtedly the best method of doing business is under some kind of departmental

government. An engineering school has naturally certain important departments like civil, mechanical, electrical and mining engineering, chemistry and perhaps architecture, each one with its staff consisting of a chairman, or head of a department, and the colleagues who join in carrying on the work of the department. It is bad, however, for any college to have too strong a departmental organization or to have one department overtopping its neighbors. Rarely can the most effective coöperation be carried out under such a system. It has always seemed to me better to have a head of a department chairman for a term of years and to have the office changing occasionally so that the chairman of the department becomes largely the mouthpiece of the professors and not the director of their work and their energy. In many colleges, departments constitute what an officer in the War Department has named a parallel organization with every bureau having full authority and no person or persons having wide professional knowledge to reconcile differences. A certain amount of emulation and competition is useful but pigheaded obstinacy or jealousy in the maintenance of one department against another is destructive of efficiency and business in a college as in the government departments.

The faculty is necessarily divided into committees for the admission of students and for supervising their work. It is almost imperative that every faculty should have as one of its committees an administrative board, whatever that board may be called, to see that the students keep to their tasks and, if they do not, let them know about it. This is really a friendship board as well as a disciplinary board because through it the students are assisted and their delinquencies are called to the attention of the faculty. A third committee is useful in any faculty—that relating to the organization of courses and the schedules leading to a degree. These three committees necessarily form the backbone of any organization, other committees being largely subordinate and effective only for short periods. It has sometimes been said that the presi-

dent of an institution ought to be a member of every committee but that seems to me unnecessary. He ought to be a member of only the committees on which he can be useful. Sometimes it is a positive disadvantage to have him a member of a committee because the member in that way lacks freedom to make up their own minds in their own way.

The arrangement of hours for lectures, recitations and laboratories commonly called the hour plan for students often presents great difficulties. It becomes almost impossible in a large university when the engineering instruction has to fit in to a long-established plan for academic study. Exactly that happened at Harvard when engineering was reëstablished in 1893. For that and other reasons the engineering department of a university must be separate from the academic department. In most cases even the language and mathematics must be given separately, thus establishing a school by itself in an alliance with the academic department, the law department and the medical department. Its methods and its purposes become thus almost the same as those of the ordinary technical school. As a rule the hour plans are too unsystematic and often demand very irregular hours on the part of the student and of the instructor. It would be worth while to make a better study of this for technical schools generally. The Naval Academy had for many years a plan of two hours assigned to each subject. This meant 8–10, 10–12, 2–4, every day. Classes were arranged in small sections having recitations one hour and then one hour for study in each of these periods. The ordinary civilian college might have something of the same arrangement. At the Worcester Polytechnic Institute the hour plan is an annual affair because it depends to some extent upon the number of students and the consequent number of divisions in each class. This becomes a serious task to some of the instructors and adds to their burdens entirely outside of teaching.

Engineering schools are constantly receiving suggestions about improvements in their courses of study. I have just

now on my desk at home either outlines or suggestions for new courses covering safety engineering, administrative engineering, business engineering, human engineering, aeronautical engineering, mental hygiene, and I do not know what to do with them. These propositions are symptomatic of the whole country where everybody has a happy thought which he is exploiting. Washington is infested with the happy thought people who are working out new plans. Our trouble is chiefly that we are not unlike the Bandarlog of Kipling's stories. We cannot in the ordinary engineering school add any new courses for we have not the space for them. We might substitute other courses in order to change the engineering program into one for business men. It seems obvious, however, that our first task is the education of young men in the fundamentals of applied science. While education ought to keep up with the times it would be a mistake to substitute for the ground work on which our profession rest, something that is merely technical and informational. No subject that has been found by long experience to be of value in developing the mind ought to be abandoned for a technical course in administration, business or aëronautics. Engineering education will gain nothing if we are led astray by the results of the war into professional courses which a man would naturally learn after graduation. Some universities and colleges have adopted in their engineering departments a straight three-year course in engineering with no specializing whatever, leaving the fourth and perhaps a fifth year for a large amount of professional work. If this can be done in such a way as to place the last years at the disposition of the department in which a young man is going to graduate the hour plan is simplified and the whole course of study is made systematic. It may be added here that a fifth year, especially if spent in another college or university would be excellent.

It has been suggested that the engineering schools ought to have a closer alliance with the engineering societies. I have written a report on that subject for the information of the

American Society of Mechanical Engineers in the hope that that society may take some share in the education of students for their profession. There are now about forty-eight student branches of the society in the United States. It is possible that our own society, the S. P. E. E., might help this relation by interesting itself in the student branches of all societies. Two points have been suggested. First, that certain scholarships should be offered to the engineering colleges having student branches, and second, that a definite program of work to be conducted by the students themselves might be planned out in a syllabus of some kind. At the present time most student branches or student societies break down because they do not have anything that really appeals to them for their weekly or monthly meetings. There is no use in a student society's attempting to repeat for the edification of its members what is given in the classroom. My belief is that some interesting subjects disconnected from the studies might be worked into a little handbook that would prove extremely valuable. I have ventured to suggest any one of the following for the coming year:

1. The general effect of the peace conference and the league of nations upon the work of the engineer, especially in commercial life of the nation during the next generation.

2. The method by which war disorganizes industries and the work of reconstruction that invariably follows every war. The general readjustment that must follow this war in all the belligerent countries.

3. Standardization for manufacture and the effect of this war in forcing engineers and manufacturers to reduce the number of parts and to simplify construction of all kinds of machines. Standardization for guns and munitions.

4. Conservation of national resources including fuel, water, soil, forest and minerals.

5. Labor and the complete readjustment of society in order that employer and employee may live together in peace. Ex-

amples of the solution of problems in different manufacturing companies.

6. The problems of transportation, national and private ownership, and the changes consequent upon improvements and rapidity of transportation.

A student branch may have a number of purposes so that the above is offered merely as a suggestion. I am listing here as a further suggestion the general purposes of student meetings.

1. To get outside lecturers on technical subjects.

2. To get outside lecturers on non-technical subjects.

3. To get salesmen or agents from manufacturers to describe their product, usually illustrating with a stereopticon.

4. To obtain lectures on general subjects from members of the general faculty with which the engineering department is connected.

5. To encourage students to speak on their feet in public meetings (*a*) by giving them the periodicals and books to be reviewed orally; (*b*) by having the results of these and investigations conducted by the student described; (*c*) by the delivery of brief addresses on non-technical subjects.

6. To broaden the contact with engineering by joint meetings with other branches of engineering in the student engineering society.

7. To bring students together, mainly for social purposes and for making them acquainted with associations and their usefulness to them personally.

8. To teach them initiative by non-interference with the student branches, thus leaving to students all activities outside of the classroom.

Just at this time we have a great deal of discussion in the United States on the subject of research. How far ought research to be encouraged in a technical school and in a university? The two types of institutions differ in this regard because the technical school rarely has the money to conduct research on a sufficient scale to make it of great value. Some

of the professors and instructors have time to do something and it is to be hoped that legitimate and proper research may be encouraged. We all know, however, the sham that often is perpetrated in the name of research. Theses are usually worthless so far as the engineering world or applied science is concerned. Furthermore, we are in a fair way to go at research in much the same way as a housekeeper would go at sweeping up a room to find a pin that had been dropped. We cannot sweep up the whole universe and our science as it is to-day will be something different to-morrow. There is room for a much better organization for study and research by bringing colleges into relation with the National Academy or with the testing departments of the great industrial firms of the country. Let us never forget in this connection the danger which science may hold for the whole human race unless we approach it in a spirit of righteousness, with a determination that it shall never be used for the destruction of all that mankind has done up to this time.

Has experience in the Students' Army Training Corps taught us anything? We must remember the two types of colleges. Those that have nothing but what is known as a general education as the end in view and those that have training for some occupation in life. The effect of the experiment with the Army varied much with different colleges all over the country. In New England it was not very satisfactory with any kind of a college. In the Middle West it seems to have been acceptable. I do not share the views of many educators, because I do not believe that we learned anything of any great value to us about courses or administration during these few weeks of military control. The war conditions taught us a great deal but it was not because we were closely allied with the Army. It is possible that colleges with no professional aim were benefited in some way. Instruction, however, suffered as the course of study were seriously interfered with and the object for which studies were given were largely lost sight of. We had a case in Worcester where young men

were sent away to the heavy artillery school from two colleges, those sent from the Worcester Polytechnic Institute having had a first-rate training in mechanical engineering and those sent from an academic college largely religious in character having had no training in engineering. This was absurd. The net result was on the whole a lesson against too much control by the Army and Navy.

If military training is to be continued it should be on terms offered by the engineering colleges and arranged in such a way as not to interfere with either administration or organization. If the specifications are supplied by the War Department in which the colleges have no voice there is certain to be the same kind of a result as that with the Students' Army Training Corps. The officers of the Army do not as a rule know much about education. Many of them have graduated from West Point which is a school of discipline—not an educational establishment—and consequently they usually err in making their plans too rigid. The summer vacation is the time for military training and under proper conditions six weeks every summer at a Plattsburg camp might be made one of the requirements for a degree. During the school year students should be under their regular faculty without any military control whatever and during the summer they could be under the discipline of the Army or Navy without any faculty control. Some additions or substitutions in the nature of physical training, military law, and the military policy of the United States might be advisable but it is doubtful if any technical training in materials for war would be worth while. Engineering schools are not unlike the professional schools of law and medicine where it would be poor business to place a military unit. Consequently any arrangement with the government ought to take into consideration the specialties for which technical schools train their students, specialties that are of the highest value in time of peace and of supreme value in time of war for manufacturing weapons and putting them into the hands of the soldiers.

I have made no attempt to go into great detail in this paper because I believe personality and character are far greater elements in the success of an engineering school than any type of administration. Our conception of man's life as one of orderly and steady development through the various schools so that a child may enter the primary department, subsequently the college, and lastly the career, without confusion, is not sound. Every one of these changes marks a sudden break and a necessary readjustment to new conditions. There is no system of instruction and no system of administration that will enable a student to glide smoothly from the secondary schools into the freshman year of college. He must get a jolt of some kind and must find himself under conditions approaching manhood where he is freed more or less from the tutelage of the home, of the boarding school or a high school. It is not necessarily a bad thing for a boy to have a break of this kind and it is rather a good thing that different colleges and preparatory schools should have their individuality. When we standardize education in such a way that all schools are alike and all teachers are alike, it will be nearly time to go back to the forest to live on nuts and berries. The chief interest in life is found in variation and no school ought to forget that.

We all know that organization depends for its effectiveness on men and women far more than on rules and constitutions. Yet some rules promote trouble and the chief effort towards college administration should be towards some system that minimizes the possibility of friction or lost motion and at the same time encourages the individual to exert his best effort. That is the only reason for administration of any kind. My conclusion is, that while the work of a college outside of the class room is interesting and while it should be well planned and carried out, the essential task is the education of boys and girls and the development of good, useful citizens capable of doing something. We have had too many examples of what administration and its unintelligent methods can do for a

department in our own government. At times it seems almost impossible to do business either during peace or war. Certainly we have much to regret over the cast-iron system based on what is known as "passing the buck" and keeping minute records of things that have no importance. It was the most unsatisfactory performance of the war and but for the manhood and courage of our young soldiers overseas the scientific management in Washington would have lost the war. It is known as red tape and every government in the world is afflicted with it.

I can see only certain essential things of a definite nature to recommend in relation to the maintenance of a college, taking for granted that as much administration is put in as will carry the work without friction. They are:

1. The time of a teacher should be occupied with administration as little as possible.

2. The class-room work of a teacher should afford him leisure for improvement in presenting his subjects to students.

3. Students should be encouraged to present and discuss subjects for themselves, usually outside of the class room.

4. The national engineering societies should be asked to coöperate not only with this association but with the colleges themselves towards broadening out engineering education.

5. The salaries of professors and instructors should be sufficient.

THE PROBLEM METHOD AT THE ENGINEERING SCHOOL, U. S. ARMY, CAMP A. A. HUMPHREYS, VA.

BY MAJOR C. C. MORE AND CAPT. W. E. DUCKERING,
U. S. Army.

The primary purpose of The Engineering School at Camp A. A. Humphreys, Va., is to stimulate and encourage the student in the exercise of his power of independent thought, reasoning and judgment, and to increase his ability to cope with new situations when confronted with them in engineering practice, rather than merely to provide him with a fund of engineering information and abstract theory, valuable as the latter are as adjuncts in his training. This purpose was laid down as a guiding principle at the very beginning, by the Chief of Engineers, Major General W. M. Black, and was emphasized continually by Colonel V. P. Peterson, Commandant of The Engineer School. In the half-year ending June, 1919, under the personal direction of Colonel Earl North and with the enthusiastic coöperation of the instructors, this object was attained in the Department of Mechanics of Engineering, by the use of methods similar to those which have been in successful operation during the past six or seven years at the University of Washington, Seattle. (The Washington method of teaching mechanics is the outgrowth of several years of experimentation carried on with the enthusiastic encouragement and support of Professor A. H. Fuller, then dean of the College of Engineering. A brief description of this method is given in an article by W. E. Duckering, in *Engineering Education*, May, 1917.)

The major portion of the classroom work was devoted to stimulating mental effort on the part of the student, and to training him in practical methods of attacking, analyzing,

and solving engineering problems, instead of being devoted to the usual methods which attempt to cover a set amount of text-book material, and center instruction around that purpose. The student was encouraged to use his own judgment and to make use of ideas which had grown out of his own previous experience. An endeavor was made to lay the foundation for future effort within the student himself, rather than in a text which he could carry under his arm. Every encouragement was offered to the development of what may be called the "engineering mind."

In this method there are two definite phases of the work: First, the phase in which study problems are used, and second, that in which drill or training problems are used. Study problems were designed for purpose of analysis rather than synthesis, with concrete engineering situations used as a basis. Where feasible, the objective ideas corresponding to technical terms used by engineers were presented by means of visits to actual engineering structures. In this manner the students were enabled to more easily visualize and understand the technical language of the engineer. For example, a bridge was visited before the first study problem was taken up. The names and functions of the various parts were discussed, and the question was raised as to the path traversed by a load placed upon the bridge, as it is transmitted through the members of the bridge, from its point of application to the ground. This introduced one of the fundamental principles of engineering thought into the minds of the students at an early stage in their training. This visit to the bridge was not made for the purpose of analyzing that particular structure but to introduce the subject of structures in general. The subsequent class-room work dealt with a different type of bridge and during the course many types of bridges were used in problems, so that the student would not be limited, in his idea of bridges in general, by the one that he happened to inspect first.

In the classroom, the first definite study problem dealt with

a pony-truss span, for which were furnished the usual engineering detail drawings showing all dimensions and sections. Military necessity required that a certain heavy howitzer be taken across the bridge. The question was asked: "Is the bridge, in its present condition, safe for this load?" With the situation before them, the students were turned loose upon the analysis of the problem. The next step, following naturally from the discussion held at the bridge site when inspecting the structure in the field, was to determine how the structure might fail. Each student was required to use his own ideas and make a list of possible sources of failure. These lists were taken up for general discussion, and from this as a starting point the students were led step by step to investigate the various members of the structure. The necessary theoretical analysis was introduced whenever required. The hanger and both chords had purposely been designed too light, thus adding an element of interest to the search for possibilities of failure. When the students discovered these members to be unsafe, they were asked to redesign them in accordance with standard specifications. Naturally, some phases of the analysis seemed too intricate for immediate treatment in the class; but these were easily deferred. For instance, in the case of the floor system, the investigation was carried to the point where the worst positions of the load were decided upon, and sketches were made showing the probable manner in which the planks, stringers and floor beams would break, but the determination of the actual fiber-stresses in these members was deferred temporarily with the understanding that it would be gone into carefully in subsequent discussions. However, the class was led to make recommendations concerning means of strengthening these parts of the bridge in case they were found to be unsafe.

At every step in the analysis of study problems, the many possible assumptions underlying the mathematical computations were always discussed at length by the class, and often two or more assumptions were taken as a basis for mathe-

matical analysis before the students were encouraged to make final judgment concerning what appeared to be in line with the best practice. In this manner the student is made to realize that engineering is not an exact science, and the element of judgment plays a very important part in all engineering problems. He also starts his career with a more open mind and a greater capacity for making advances along new lines of engineering thought. He develops a keen interest in engineering literature, especially current engineering periodicals and papers and discussions of engineering societies. Students are not subject to the limitations of a single text, but find it advantageous to refer to several. An inevitable result of this kind of training is the tendency of the student to rely more and more on his own judgment with respect to making assumptions, and in all his work the student shows a greater self-reliance and an increasing desire to do independent thinking.

The chief purpose of the drill problems are to furnish vehicles for training, and for fixing the use and understanding of the fundamental principles firmly in the mind of the student by well-directed repetition. Practically all review work had these purposes in view, though it was possible to use these problems as a means of grading the students and of giving them their section rating. The purpose of these problems, held before the mind of the student, is the opportunity to set up good habits of analysis and work, and to increase by means of carefully organized and well executed computations and sketches, his power to get accurate results and develop speed, while at the same time each problem makes him more at home in the use of the necessary mathematics and mechanics. In order to aid in the accomplishment of these purposes, the major problems were broken up into a large number of subproblems so that the arithmetic might be made easy and so that particular attention might be directed to a great variety of special uses of the fundamental principles. In order that the student would know how to organize his work with a view

to the development of speed and accuracy in execution, and as an aid to clearness of thought, he was required to work in accordance with a definite set of specifications covering the means whereby system, clearness, and accuracy may be attained. He was taught to recognize the importance of each step in the solution, as a link in the chain leading to a final result, and to surround his computations with as many safeguards and checks as necessity and time permitted. The result of this training in the mechanical side of analysis, was to increase tremendously the accuracy of the work. The student found himself not only getting more definite results but he also developed the power to find and correct his own errors. All this tended to increase his pride in his work and to give him confidence in himself; while at the same time he was forming good habits of thought and work which could be transferred to his engineering practice later on. In short, the class-room work was made to approximate actual engineering experience as closely as possible.

The results obtained make it clear that a system of instruction designed along the lines sketched above, does decidedly awaken and hold the interest of the student in the live problems of the engineering world. It does increase the confidence with which the student tackles a problem and stimulates his self-reliance and initiative, and at the same time he shows greatly increased industry and speed of learning. This is further accentuated by the fact that no grading is done on study problem work. The student is left free to take chances in doing independent thinking. The grading for purposes of classification in sections is based entirely upon work done on drill problems. The student is given to understand, however, that the only grades which effect his final passing in the course are those determined in the last four or five weeks of work, when nothing but review problems are taken up. His desire to work for passing marks becomes secondary and is dwarfed by his desire to understand engineering theory in order that he can use it in his work. His career as an engineer has begun.

THE PROBLEM METHOD AT THE ENGINEER SCHOOL.

This method of teaching mechanics offers unusual opportunities for instructors to do original work, by bringing in new problems derived from their own experience, and by making improvements in the methods of presentation and instruction. During the course at The Engineer School the class-room instructors suggested and worked out several study problems of great value and they also discovered certain new applications of theory which greatly amplified the work in some parts of the subject, and extended the usefulness of certain laws. The following officers were class-room instructors and to them is due great credit for the success of the course; Majors O. O. Kuentz and H. W. Sibert, and Captains L. Graham, W. E. Duckering, W. A. Lyon, E. R. Hyde and G. M. Steese.

EDITORIAL.

College Administration.—Seldom has there appeared a better presentation of the different phases of college administration, than the article by President Hollis of Worcester Polytecrnic Institute, appearing in this number of ENGINEERING EDUCATION.

The object of administration in colleges should be to assist the teachers. There is no other excuse for an administrative organization. If the administration requires the teacher to take an undue amount of time from his teaching duties to make reports, attend committee meetings, needless faculty meetings, etc., then the administration fails to accomplish its object. It is unfortunate that the trustees of many institutions come in contact only with the problems of administration with the result that the administration seems to be the institution. Many have the point of view of the trustee who happened to meet the editor in the office of the superintendent of buildings, and in the course of conversation said that this office, *i. e.*, the superintendent's office, was the most important one in the institution, showing that he failed to comprehend the reason for the existence of such an office which is simply to provide proper space for teaching. A multiplication of records and reports absorbs the time and the energy of the teacher which should be devoted to the preparation of his work of teaching and research. The administration should be so simple and flexible that the teacher does not know that it exists. If, under such an organization, certain men fail to function properly, it demonstrates the fact that they are not the proper type of men for teachers.

Often in the discussion of college administration the idea is conveyed either directly or indirectly, that administration is one factor and teaching another. As an actual fact we know that the two are one and the same. Administration can not be separated from teaching. Probably in no other organization does such a separation occur. It is, perhaps, unfortunate that the word administration, has come into such universal use in connection with college organization.

AIMS OF ENGINEERING SCHOOLS.*

The controlling consideration in the selection of the teaching staff and in the planning of the instruction in the new Harvard Engineering School are thus stated by President A. Lawrence Lowell: "To train men to think; to lay a broad and deep foundation with a superstructure which can be completed only gradually from the training and observation that come from practical experience; to encourage the student to understand each problem so thoroughly that he can apply the same principles intelligently in the solution of different kinds of problems; and, finally, to train men to be good citizens as well as good engineers." President Lowell has expressed in a few words the principles that are probably subscribed to in theory by all engineering teachers, but which, on an impartial study, many of them would have to admit had been violated in the planning and conduct of engineering courses. What we have been trying to do in discussions of engineering education lately is not so much to discover new principles as to prove again to ourselves the validity of old principles, and to inquire whether the methods we have been pursuing square with what is sound in theory. President Lowell's declaration is a good one. We find the same principles widely subscribed to. We hope, however, that all who accept them in theory will remember the homely phrase that "the proof of the pudding lies in the eating thereof." Do engineering courses produce the results that President Lowell lays down as the purpose of the new engineering school?

* *Engineering News-Record*, Vol. 83, No. 9, p. 397.

LETTER TO THE EDITOR.

It certainly sounds like a noble thing for a professor to aspire to teach his pupils to think and to do research work and to accomplish something beyond the mere acquisition of information. Articles written with such ideas in mind and proposing to teach students to invent and originate, read very beautifully. I feel, however, that such articles are only visionary and that the writers have their heads in the clouds.

An almost negligible percentage of pupils have power to invent and do original research work. This power cannot be given by any amount of instruction. If courses are therefore planned with the idea of developing such powers, they will only suit an exceedingly small percentage of the pupils. It is very often the case that the majority of the pupils in the class are in a haze as to what the instructor with such ideals is talking about.

If any engineering instructor will take a census as to what his pupils are doing five or ten years after graduation, he will find very, very few doing original research work, and a very large majority using detailed information of various kinds which they have to grope for in engineering handbooks and the like, because they were not given concrete details during their college course. The very few pupils who are fitted to do research work and think independently have no need of any special training in this direction. They can profit greatly by the same sort of course as is given their less original classmates. They themselves have the necessary power to add to such a course, whatever is necessary.

SANFORD A. MOSS.

May 6, 1919.

COLLEGE NOTES.

Colorado School of Mines.—Professor A. P. Little, formerly of the Bureau of Standards, who has been at Yale during the past year in connection with the Signal Corps Training School for Officer Candidates has been appointed professor of electrical engineering.

University of Kansas.—C. M. Young has resigned from the position of assistant professor mining research at the University of Illinois to take that of professor and head of the department of mining engineering at the University of Kansas.

Lehigh University.—Ralph J. Fogg, a member of the civil engineering department for eleven years, has been appointed professor of civil engineering and head of the department, and Dr. Fred V. Larkin, for the past four years assistant superintendent of the Harrisburgh Pipe and Pipe Bending Company, has been appointed professor of mechanical engineering and head of the department.

Massachusetts Institute of Technology.—Dr. V. Bush has been appointed associate professor of electrical engineering. Dr. Bush is a graduate of the Electrical Engineering Course of Tufts College and received an M.S. degree from that college in 1914. He received the degree of doctor of engineering from the Massachusetts Institute of Technology in 1918.

Messrs. Frederick S. Dellenbaugh, Columbia University, 1910; Arthur L. Nelson, Massachusetts Institute of Technology, 1915; and F. B. Philbrick, Massachusetts Institute of Technology, 1918, have been appointed instructors in electrical engineering.

Sheffield Scientific School of Yale University.—L. W. W. Morrow, who has been at Yale on leave of absence from the University of Oklahoma during the past year, is retained at Yale as assistant professor of electrical engineering.

G. F. Wittig has been made assistant professor of electrical engineering in the Sheffield Scientific School. He has been at Yale during the past year, first in connection with the Signal Corps Training School for Officer Candidates and after its disbanding has been a member of the physics department.

H. M. Turner has been made assistant professor of electrical engineering in the Sheffield Scientific School.

The University of Minnesota.—The board of regents of the University of Minnesota voted that Dean Lauder W. Jones, who is at present dean of the School of Chemistry, should also fill the position of dean of the College of Engineering and Architecture. They have in mind the correlation of the work of these two colleges and hope at some future time to combine with them the School of Mines and make at this university an Institute of Technology. Dean Jones assumed his duties July 15.

BOOK REVIEW.

The Civil Engineer's Pocket-Book. By JOHN C. TRAUTWINE, Civil Engineer. Revised by JOHN C. TRAUTWINE, JR., and JOHN C. TRAUTWINE, 3D, Civil Engineers. Twentieth edition. xxxii + 1,528 pages. Trautwine Company, Philadelphia. Price $6.00.

This, the twentieth edition of this famous handbook, is a worthy successor of the previous volumes. Three hundred and twenty pages of new matter have been added and much of the former material has been condensed and arranged in a better manner.

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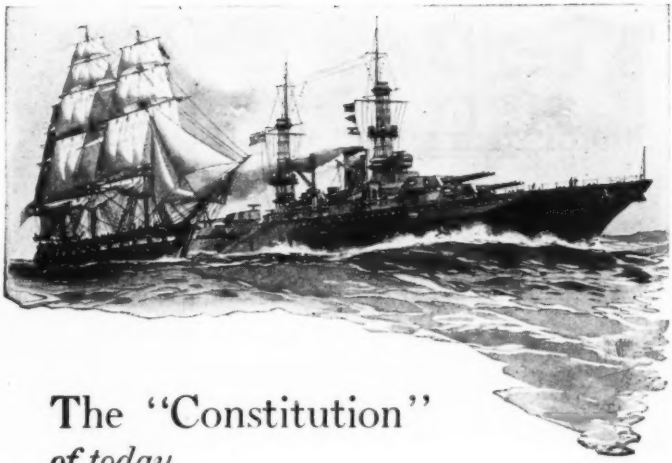
The physical appearance of the book is good, the typography clear and the thumb index furnishes a ready means of quick reference.



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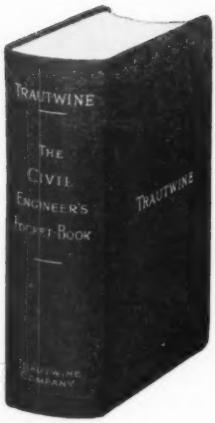

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